BOOKBINDING MACHINE AND METHOD FOR INDIVIDUAL BOOKBINDING SYSTEM

BACKGROUND OF THE INVENTION

Cross-Reference to Related Application

This application claims priority from Provisional Patent Application 60/446,015, filed on February 6, 2003, entitled "Bookbinding Machine and Method for Individual Bookbinding System."

Field of the Invention

The present invention relates to systems and methods for binding pages together, and, more particularly, to such systems and methods for binding individual books.

Description of Related Art

A variety of different techniques are known for binding books. At one end of the spectrum is the so-called perfect binding technique used for paperback books. Individual page sheets are bound directly to the inside of the spine of the cardboard cover using a hot-melt adhesive that is solid at room temperature. Perfect binding is suitable for paperback books produced in large quantities. The high-volume machines used for perfect binding are very large and costly and must be set up for each run of books, a time-consuming process that often results in making trial copies that must be discarded. High-volume perfect binding machines are not practical for running single copies of books such as those downloaded from the Internet.

Thermal tape is another means for binding books and is often employed as a finishing operation for high-volume xerographic duplicators. The pages are individual sheets, usually 8½ x 11 inches, and the covers are cardboard sheets of the same size as the pages. Paper tape coated on one side with hot-melt adhesive forms the spine of the book, and the adhesive is activated as it passes over heated surfaces inside the machine. There is no way to print the title and author's name on the spine unless pasted on in a separate label. While thermal tape is a convenient method for binding small lots of booklets such as college course packs, such booklets do not offer the aesthetic appeal of high-quality bound volumes.

There are various other means for binding small quantities of books using staples, plastic combs, wire spirals, and plastic posts, none of which provides the look and feel of a fine bound volume.

A preferred method for binding books is the traditional cloth binding technique used for hardcover books. The pages are printed on large sheets called signatures, which are then folded, sewed and glued together, and then trimmed. The cover consists of front and back cardboard pieces encased in decorative cloth binding material, which also forms the hinges and outer spine. Cloth binding has advantages of quality appearance, durability, and ease of page turning, since the pages are glued to a flexible inner cloth spine that is fastened to the outer spine only at its edges. Like perfect binding, cloth binding is a high-volume process involving the use of large and costly machines, and is therefore not suitable for binding single copies. There are a few craftsmen who specialize in custom binding or repairing single cloth bound books, but such work is highly skilled and expensive.

At the high end of the spectrum are leather-bound books. Produced by a process similar to cloth binding, leather-bound books offer the ultimate in luxurious appearance.

It is known in the art to heat a hot-melt adhesive onto page edges to bind a book with an external heater. It is also known to heat a hot-melt adhesive coated on an electrically resistive layer applied to the inner surface of a report binder with the use of a power supply. It is also known to use a microwave-activatable adhesive to bind books, with the adhesive placed between a sheaf of papers and the binder. Additionally, it is known to employ individual book-binding apparatus following the printing of a book from a storage medium such as a database.

Although there is widespread interest in methods for binding cut sheets from desktop computer printers into high-quality books, no commercially viable, easy-to-use device has been disclosed.

SUMMARY OF THE INVENTION

The present invention provides systems and methods for binding an individual book that has superior aesthetic qualities, can create a book with a plurality of cover types, including both hard covers and soft covers, and are easily adaptable to books of various sizes. Books made by the present systems and methods do not require trimming of the book or the binding strip upon completion of the binding process.

A method of the present invention is directed to binding a stack of pages to form a book. This method comprises the steps of placing a flyleaf inside a book cover, a spine of the flyleaf being affixed to a spine of the book cover, and placing an electrically

resistive strip adjacent an inside of the flyleaf spine of a book cover. The strip has a hot-melt adhesive in contact therewith, for example, as a coating upon or impregnated into the strip.

A stack of pages desired to be bound is positioned inside the flyleaf, a binding edge of the page stack adjacent the strip, to form a book assembly. Pressure is applied to an outside of the flyleaf adjacent the strip and along the page stack binding edge, with the strip positioned between the flyleaf spine and a region of pressure application.

An electrical current is passed along the strip to create heat sufficient to melt the adhesive. The melted adhesive serves to bind together the binding edge of the page stack to the flyleaf spine and to affix a first and a last page of the page stack to the flyleaf adjacent the flyleaf spine. When the current is discontinued, the adhesive is permitted to solidify following the electrical current's being stopped and prior to removing the pressure.

The features that characterize the invention, both as to organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description used in conjunction with the accompanying drawings. It is to be expressly understood that the drawings are for the purpose of illustration and description and are not intended as a definition of the limits of the invention. These and other objects attained, and advantages offered, by the present invention will become more fully apparent as the description that now follows is read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A-1D illustrate a first embodiment of elements and a method for binding hardcover books with superior aesthetics.

FIGS. 2A-2D illustrate a second embodiment of elements and a method for binding hardcover books with superior aesthetics.

FIGS. 3A-3D illustrate elements of the page stack alignment fixture and the method of using same.

FIGS. 4A,4B is a top-side perspective view of exemplary removable clips for attaching clip leads from a power supply to the binding strip.

FIG. 5 is a view of an embodiment of the bookbinding machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description of the preferred embodiments of the present invention will now be presented with reference to FIGS. 1A-5.

In the present invention, the term "book" may comprise any collection of individual sheets that are desired to be bound together, and should not be taken as a limitation. Preferably all the pages should be of substantially the same size.

The invention is contemplated for use in such applications as binding a stack of pages that have been collected together or printed from a source such a desktop computer printer, as a download from a remote location (e.g., a site on the Internet), or a storage medium such as a disk. However, this application is not intended as a limitation, and one of skill in the art will understand that the invention may be used in any binding situation.

The present invention is generally directed to the binding of books wherein electric current is used to melt adhesive positioned adjacent a page stack edge desired to be bound in a hot-melt binder. The hot-melt adhesive is supplied in solid form, precoated on or impregnated into an electrically resistive strip. In use, the width of the adhesive strip is first trimmed to the approximate thickness of the page stack of the book, such as by using ordinary office shears or a paper cutter. Similarly, the length of the strip is trimmed to the approximate length of the page stack. Alternatively, various precut widths and lengths of strips may be supplied to a consumer.

In the embodiment of the system **10** and method of the invention shown in FIGS. 1A-1D, a cover assembly **80** is made by affixing a pair of liners **801,802** to an inside of front **803** and back **804** cover pieces, each liner **801,802** comprising a cover portion **803** and a spine portion **806** meeting at a fold **807**. The cover pieces **803,804** comprise substantially planar, substantially rigid rectangular elements suitable for making a hardcover book. The book assembly **80** further comprises a substantially planar, substantially rigid, typically rectangular spine **808**.

The cover assembly **80** is created by placing an inner edge **809** of each cover piece **803,804** adjacent respective lateral edges **810,811** of the spine **808**. The liners **801,802** are positioned so that their cover portions **805** are substantially parallel, with one of the spine portions **806** atop the other spine portion. A flexible covering **82** is affixed to an outside of the front **803** and the back **804** cover pieces and the spine **808** in covering relation to at least a seam region **83** where the spine's lateral edges **810,811** meet the respective inner edges **809** of the front **803** and the back **804** cover pieces.

A pair of flyleaf elements **814,815** each comprises a cover portion **816** and a spine portion **817** meeting at a fold **818**. The flyleaf elements **814,815** are positioned so that their cover portions **816** are substantially parallel, with one of the spine portions **817** atop the other spine portion.

An electrically resistive strip **11**, which has been coated or impregnated with a hot-melt adhesive **111**, is affixed using an adhesive, such as, but not intended to be limited to, a pressure-sensitive tape **12** that has been applied to a back **110** of the strip **11**, to the top flyleaf spine portion **817**. The resistive strip **11** may have been trimmed to a desired dimension commensurate with the dimensions of the binding edge **131** of a page stack **13** desired to be bound. Alternatively, the resistive strip **11** may be supplied precut to match the standard lengths of various books. Clip leads **14** are removably attached to each end of the strip **11** (FIGS. 4A,4B).

The page stack **13** is positioned between the flyleaf elements **814,815** so as to rest on the resistive strip **11**, with the binding edge **131** adjacent the strip **11** (FIG. 1B). This step may be facilitated by using a page stack carrier **15** to surround at least a portion of a free edge **132** of the page stack **13**. The free edge **132** is opposed to the binding edge **131**. The page stack carrier **15** helps to retain an alignment of the pages during the binding process, and may comprise, as shown, a container dimensioned to receive the page stack.

In this embodiment, a pair of elongated, substantially cylindrical spacers **16** are placed between each of the flyleaf elements **814,815** and the respective book cover piece **803,804**, between the strip **11** and the page stack's free edge **132**, but fairly close to the strip **11**.

The front **803** and back **804** cover pieces are folded upward along the sides of the page stack **13**, and the book assembly **17** is placed into an adjustable-width substantially squared-U-shaped holder, such as, but not intended to be limited to, the bookbinding machine **18** shown in FIG. 5 to maintain the position of the parts during the binding process. This particular machine **18** will be discussed in the following.

Pressure is first applied to an outside of the flyleaf elements **814,815** adjacent the strip **11** along the page stack's binding edge **131** sufficient to hold the book assembly **17** in position. A source of electrical current in contact with the leads **14** is activated, so that the flow of current for a predetermined time heats the resistive strip **11**, causing the adhesive **111** to melt. An exemplary binding voltage comprises approximately 5 volts rms to yield an exemplary binding current of approximately 5 amperes rms, and the predetermined time is typically 1-2 minutes.

During the heating cycle, the page stack **13** is pressed against the strip **11**, preferably applying a scrubbing motion to the page stack **13** for increasing contact between the binding edge **131** and the melted adhesive **111**. This method exposes all the pages to melted adhesive **111**, and forces melted adhesive **111** between the flyleaf portions' folds **818** and onto the first and last pages of the page stack **13**.

At the conclusion of the heating cycle, the current is turned off, the clip leads **14** are removed, and the page stack **13** is pressed downward toward the spine **808** to fill any spaces previously occupied by the clip leads **14**. Additional clamping pressure is then applied to a pressure-application region outside the cover pieces **803,804** and adjacent the spacers **16**, so that a region of the flyleaf covers **816** adjacent the flyleaf

portions' folds **818** is glued to the first and last pages of the page stack **13**. This technique hides an unsightly gutter between the page stack **13** and the cover **80**.

The assembled book is then left in the holder **18** for several minutes while the adhesive **111** completely solidifies, typically for a period of approximately 10 minutes. The page stack carrier **15** is also removed. Following solidification, the clamping pressure is released, and the completed book is removed from the bookbinding machine **18**.

In a second embodiment **30** of the invention (FIGS. 2A-3D), a cover assembly **31** is created substantially as for the first embodiment **10**. Here, however, the liner **32** and the flyleaf **33** are each unitary elements. The liner comprises a single sheet folded to form a spine portion **321** and two cover portions **322** meeting at folds **323**. The flyleaf **33** comprises a single sheet folded to form a spine portion **331** and two cover portions **332** meeting at folds **333**, with an additional inward fold **334** that partially covers the strip's lateral edges **112**. The inward folds **333,334** may be prescored.

Another feature of this embodiment **30**, which could also be used with the first embodiment **10**, includes a page stack alignment device (FIGS. 3A,3B) **40** for use in maintaining page alignment and also provides a feature for defining a pressure application region. The alignment device **40** comprises a pair of alignment elements **41,42**. Each alignment element **41,42** has a pair of substantially rigid and substantially planar support elements **411,421**, each support element having a first **412,422** and a second **413,423** cover guide extending along an outside of at least a portion of a first **414,424** and an opposed second **415,425** edge of the support element **411,421**, respectively. The first **412,422** and the second **413,423** cover guides are separated by

at least a height **819** of the book cover **80**, at least one of the support elements **411,421** (here, the first **411**) further having a first **416** and a second **417** page stack guide extending along an inside of at least a portion of the first **414** and the second **415** support element edges, respectively. The first **416** and the second **417** page stack guides are separated by at least a height **134** of the page stack **13**. A flexible tape **419** may be used to connect the first **411** and the second **421** support elements together adjacent at least one of the pairs of edges **414,424;415,425** for ease of handling.

In this embodiment **30**, the page stack carrier **15** is placed over the free edge **132** as above, and the alignment device **40** is positioned to straddle the page stack carrier **15** and the flyleaf cover portions **816**. The page stack **13** is positioned between the support elements **411,421** as shown in FIGS. 3B-3D, the top **135** and bottom **136** edges of the page stack **13** in bounding relation to the first **416** and a second **417** page stack guides. The alignment device **40** is then slid downward so that the lower edges **418,428** of the support elements **411,421** reach the inward folds **334** of the flyleaf **33** until the top parts of the inward folds **334** cover the strip's lateral edges **112**. The top and bottom edges of the cover **80** are bounded by the first **412,422** and a second **413,423** cover guides. Using the alignment device **41**, the page stack **13** can be positioned within the cover **80**, the page stack **13** centered along the midline of the strip **11**, and midway between the top **821** and bottom **820** edges of the cover **80**.

The steps of clamping the jaws of the bookbinding machine sufficiently to hold the book assembly **43** in position, applying electrical current along the strip **11** to melt the adhesive **111**, turning off the current, pressing on the page stack **13** to expose the pages to melted adhesive **111**, removing the clip leads **14**, and pressing the page stack

13 downward are substantially as above. The alignment device **40** is used to press the flyleaf's inward folds **334** into the melted adhesive **111** (FIG. 3C). The additional clamping pressure is then applied in the region of the inward folds **334**. The cooling, solidifying, unclamping, and book-removal steps are substantially as above.

This system and method offer several advantages:

- Pre-scored sections of the flyleaf **33** adjacent the strip **11** can be folded down and glued in place at the time of binding to cover the unsightly gap in the gutter between the page stack **13** and the inner surface of the cover **80**.

- By prescoring a series of parallel folds in the flyleaves, a single cover size and resistive strip **11** can accommodate a wide range of page stack thicknesses (e.g., from 1/8th to 1/2 inch). This would be desirable for creating digital photo albums, for example, which might contain from 10 to 50 pages. (Each page of inkjet photo paper is about 10 mils thick.) The thickness of the cover portions **803,804** can be chosen to provide the most pleasing aesthetics for the book, with covers neither excessively pinched in nor bulging out relative to the spine width over the expected range of page stack thicknesses.

- Maintaining a minimum cover spine width of at least 1/2 inch is desirable to accommodate lettering on the spine, for example a book title in hot-stamped gold letters. This construction permits the spine width to be maintained at 1/2 inch even with thin page stacks (e.g., 1/8th inch).

- The hinges of the cover are mechanically isolated from the binding of the page stack, so that the cover opens easily without creating stress in the page stack binding that might cause the binding to split.

A page stack alignment fixture **40** fabricated from hardboard, plastic, wood, or similar material (FIG. 3A) is designed with guides to center the page stack along the midline of the resistive strip **11** and midway between the top and bottom edges of the cover. It also provides a means to press the folded bottoms of the flyleaves against the melted adhesive at the conclusion of the heating cycle to cover the unsightly gutter.

A method for binding a paperback book is similar, although some steps preferred for binding hardcover books are omitted: Using the small pads of pressure-sensitive tape **12** that are supplied on the back of the binding strip **11**, tack the binding strip **11** to the inside spine **806** of the empty book cover **80** (FIG. 1B). Attach removable clips **14** to the ends of the resistive strip **11** (FIG. 4B). Place the empty cover **80** between the jaws of the bookbinding machine **18** and attach the clip leads **14** to the strip **11**. Insert the page stack **13** into a page stack carrier **15** (see FIG. 1B) and place it in position within the cover **80**. Clamp the jaws of the bookbinding machine **18** just enough to hold the cover **80** and page stack **13** in position. Switch on the power and adjust the current control. After 1-2 minutes of heating, press down on the page stack carrier **15** with a scrubbing motion to expose all the pages to the melted adhesive **111**. Switch the power off, immediately pull out the clip leads **14**, and press down firmly on the page stack carrier **15** to fill any spaces previously occupied by the clip leads. Check alignment of all parts and clamp firmly; allow the bound book to cool for 10 minutes so that the adhesive **111** can completely solidify.

An exemplary embodiment of the bookbinding machine **18** of the present invention is illustrated in FIG. 5. A low-voltage power supply **181** is surmounted by a

rigid binding platform **182**. To avoid short circuits if accidentally touched by the clip leads **14** during the binding cycle, the platform **182** is made of a nonconducting material such as wood or plastic, the jaws **183** that clamp the book during the binding cycle have insulating coatings, and the clip leads **14** are insulated except for the tips. The binding platform **182** extends beyond the lateral extent of the power supply **181**, facilitating carrying the device **18**.

In an exemplary embodiment, the stationary and adjustable jaws **183** are 14 in. long, so that it is possible to bind books from pocketsize to coffee table-size, having spine lengths ranging from 2 to 14 in. The space between the jaws **183** can be adjusted by means of a knob **184** and lead screw **185** to accommodate books up to 2 in. thick.

The insulated clip leads **14** provide flexibility to connect the power supply **181** to the resistive binding strip **11** of books of any size in the range of spine lengths and thickness specified above.

The front-mounted control panel contains a power switch **187** that is illuminated when the power is on, a knob **188** for adjusting the binding current, and a meter **189** for measuring the binding current to set the optimal binding current for books of various sizes. Experiments have shown that it is important to control the binding current. If the current is too low, the melted adhesive will not achieve and hold the low viscosity (typically less than 5000 centipoise) necessary to soak up into the edges of the page stack **13** to ensure optimal binding strength. If the current is too high, the spine **801** of the cover **80** may be scorched. Since the power dissipated in the binding strip **11** is proportional to the square of the current, accurate control of the current is very important.

The solid-state power supply **181** provides a low-voltage pulse-width-modulated ac binding voltage to minimize contact resistance losses that would be excessive if, for example, variable-voltage dc were to be used. For safety, the binding voltage is typically about 5 volts rms and the binding current is typically about 5 amperes rms. The design of the power supply circuitry is straightforward for someone skilled in the art of electronic power supplies. If desired, a binding cycle timer (not shown) to switch off the power at the end of the binding cycle could be added.

In the foregoing description, certain terms have been used for brevity, clarity, and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for description purposes herein and are intended to be broadly construed. Moreover, the embodiments of the apparatus illustrated and described herein are by way of example, and the scope of the invention is not limited to the exact details of construction.